# ROTATABLE BUSHING FOR REDUCING BENDING STRESS IN ELECTRICAL CABLE

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a system to reduce bending stress on conductive cables, and more particularly to reduce wear on a flex cable between the base of a laptop computer and a pivotable display screen.

2. Description of the Related Technology

Portable personal computers, such as laptop or notebook computers, have become quite popular in recent years. The increased demand for such computers has been partially due to the compact size of these computers which make them ideal for travel or in applications where work space is limited.

In order to maximize space efficiency and facilitate portability of these laptop and notebook computers, most of these computers have an LCD display screen which pivots or folds down into a closed position over the computer keyboard. Although this is useful in conserving space and protecting both the screen and the keyboard during travel, etc., the pivotable display screen requires certain necessities. In particular, the display screen must be electrically connected to the base of the computer by wires or other suitable connection means. For most of these computers, opening and closing of the display screen requires that the wires bend through a relatively large angle. In some recent applications, this angle may be as large as 180°. Thus, constant opening and closing of the display screen may cause extensive wear on the wires due mostly to bending stress or frictional contact with the hinge between the screen and the base of the computer.

Therefore, a need exists for a suitable system which reduces wear due to bending stress on cables between the display screen and the base of a portable computer.

## SUMMARY OF THE INVENTION

Briefly stated, the invention includes an electrical device, such as a laptop or notebook computer, having a suitcase-type construction that includes a base having a keyboard, and a hinged cover including a computer screen. A flexible electrical cable connecting the screen to circuitry in the base extends through a slot in a bushing which is rotatably mounted in the hinge. The bushing is free to rotate with respect to the hinge as urged by the cable during opening and closing movement of the cover. This arrangement effectively causes the cable to bend at two spaced locations rather than one, as would be the case if the bushing were fixed to either the base or the cover. Thus, bending stress on the cable is minimized and its useful life is correspondingly lengthened.

In a preferred form of the invention, a protective sheath also extends through the bushing slot and surrounds the portion of the cable extending through the bushing. Preferably, both the cable and the bushing are affixed to the cover close to the hinge axis. Ends of the sheath extending into the base are free with respect to the cable and the base, and the cable of course has some slack within the base to accommodate limited movement. With this arrangement, any friction introduced by the bushing is felt by the sheath rather than the bushing. Preferably, the sheath is formed by two thin, flexible sheets of opaque, low-friction plastic material.

The method of the invention includes mounting the cable, bushing, and sheath as outlined above.



## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a portable computer having a cable protector constructed in accordance with the present invention.

FIG. **1***a* is an enlarged cutaway view of the region where the cable extends between the display screen and the base of the computer shown in FIG. **1**.

FIG. **2** is a perspective view of a pivot bushing forming part of the cable protector of FIGS. **1** and **2**.

FIG. **2***a* is an end view of the pivot bushing shown in FIG. **2**.

FIG. **2***b* is an exploded view showing two halves which join to form the pivot bushing of FIG. **2**.

FIG. **2***c* is a cross-sectional view along the line **2***c*–**2***c* of FIG. **2** which shows the ribbed supporting structure of the pivot bushing.

FIGS. **3***a*–**3***c* are schematic views which show the overall orientation of the connecting flex cable and the pivot bushing within the computer when the display screen is closed, opened to a 90° angle, and opened to a 180° angle, respectively.

FIGS. **4***a*–**4***c* are enlarged views of the pivot bushing area in corresponding FIGS. **3***a*–**3***c*, respectively.

## DETAILED DESCRIPTION OF THE INVENTION

Referring to FIGS. **1** and **1***a*, an electrical product in the form of a computer **100** includes a base **110** with a keyboard **111**, and a pivotable cover **112** including an LCD display screen **115**. The cover **112** connects to the base **110** by means of suitable support hinges **120** and **122**, to form a suitcase like construction. A flexible connection cable **125** (shown in phantom in FIG. **1**) extends between the base **110** and the screen **115**. The cable **125** is a thin, generally flat, flexible but yet somewhat stiff cable having a plurality of electric conductors **128** running therethrough. The cable **125** connects circuitry (not shown) within the base **110** of the computer **100** to the appropriate driving inputs (also not shown) of the display screen **115**.

The cable **125** passes through an elongated, generally cylindrical pivot bushing **130**. The longitudinal axis **190** of the pivot bushing **130** is advantageously aligned with the hinge axis which extends through the hinges **120**, **122** between the screen **115** and the base **110** of the computer **100**.

The cable also passes through a sheath **139** formed by a pair of shields **140**, which are flat, thin sheets of preferably opaque plastic, such as Mylar® Plastic Sheets. The sheath protects the cable **125** and prevents the cable from being exposed to view when the cover **112** is in the open position. The pivot bushing **130** reduces wear on the flex cable **125** due to bending stress, and the sheath **140** prevents wear due to frictional contact.

As shown more clearly in FIGS. **1***a*, **2** and **2***a*, the pivot bushing **130** includes a slot **150** which is wide enough to allow the cable **125** and a portion of the shields **140** to pass through. The shields include laterally extending projections **155**, which are wider than the slot **150**, so that they are not able to pass through the slot. The projections facilitate insertion of the cable **125** between the shields **140** and through the slot **150** because the shields **140** are not free to slide completely through the slot, although limited movement between the shields and the bushing occurs during hinging action of the cover.